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RASTER COMPUTATION OF RELIEF

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Abstract: The present paper shows a Tnt Mips SML (Spatial Manipulation Language) implementation of relief computation using a DEM in raster format.

Rezumat: *Modelizarea raster a reliefului***.** Acest studiu îşi propune să utilizeze Tnt Mips SML (Spatial Manipulation Language) pentru măsurarea reliefului în format raster cu ajutorul Digital Elevation Model.

Key words: *raster, relief, Digital Elevation Model, Spatial Manipulation Language, kernel window size*

Introduction

Relief is a geomorphometric parameter that is equal with the difference of altitude between the maximum and minimum altitude from a reference area (Zakrzewska, 1964, Ahnert, 1984). The relief was introduced (according Ahnert, 1984) by Partsch (1911) under the name „Reliefenergie". Later, in the Anglo-Saxon literature it was simply named „relief" or "relative relief". In Romanian literature it was named „vertical fragmentation of relief", „depth of landform fragmentation" (Ungureanu Irina, 1978, Grigore, 1979), or the „energy of relief" (Grigore, 1979, Ichim, 1998).

Because the relief is a difference of altitudes, it can be considered a first derivative of altitude, and a first derivative geomorphometrical parameter.

The relief is a local geomorphometrical parameter after the Sharry et. al, 2002 classification of geomorphometrical parameters. But in very high kernel windows (bigger than 900 m) relief can become a regional geomorphometrical parameter (this is when the reference surface becames a significant geomorphological area like a hydrographic basin).

Raster computation in SML

The classical method for computation of relief was the construction of a grid overlapped on the topographic map and the determination of the difference between maximum and minimum altitude in every grid cell. The size of the grid cell was usually 1 km² or larger. The results of this method are very generalized.

The raster format of a Digital Elevation Model support a very simple computation of relief: the difference between maximum and minimum altitude

in a square kernel window of different sizes (3x3 cells, 5x5 cells, 7x7 cells, 9x9 cells, etc). The result of this method shows a more detailed spatial distribution of relief values. The result is a raster of relief values for every pixel of initial raster. So, for every pixel from the DEM we have a value of the relief in a square vicinity of x pixels.

This is not a new idea and was implemented by others in GIS (Brabyn, 1998, Guth, 2006). However here we implement the raster based calculation of relief using a filter window kernel in TntMips software using the Spatial Manipulation Language scripting and we make some comments.

SML script– square kernel

```
#Add the DEM------------------------------------
GetInputRaster(A)
#Save as the new relief raster--------------------
GetOutputRaster(B)
#Copy all subobjects from DEM to the new raster---
CopySubobjects(A,B)
#for every cell of raster DEM computes the difference between the maximum and minimum altitude in a square focal kernel of x,x pixels---
for each A begin
B=FocalMax(A,x,x)-FocalMin(A,x,x)
    end
```

Implications of the size of the kernel window

In general geomorphometry it was statted as a rule (Evans, Sharry et al., 2002) that geomorphometrical parameters computed from digital elevation model, but not only, tend to become smaller in value with the increase of resolution. This is related to the generalization of relief shape with the increase of resolution. In relief case the increase of kernel window calculation size increases the relief value, because in larger areas the maximum and minimum are *bigger, smaller*, and *respective* (Figure 1, 2, 3). But if we compute the relief at different resolutions with the same windows size we will see that relief values decrease, in concordance with the rule shown before (Figure 4).

The present method of relief raster computation was applied on a SRTM digital elevation model which covers the central part of Bârlad river basin (Figure 5) at various resolutions and kernel window size. We can see that with decreasing numerical resolution we have a more clear visual representation of relief. With increasing kernel window size the results are more blurred and we can see some patterns related to the form of the kernel window (Figure 5, SRTM90 30 pixels kernel size).

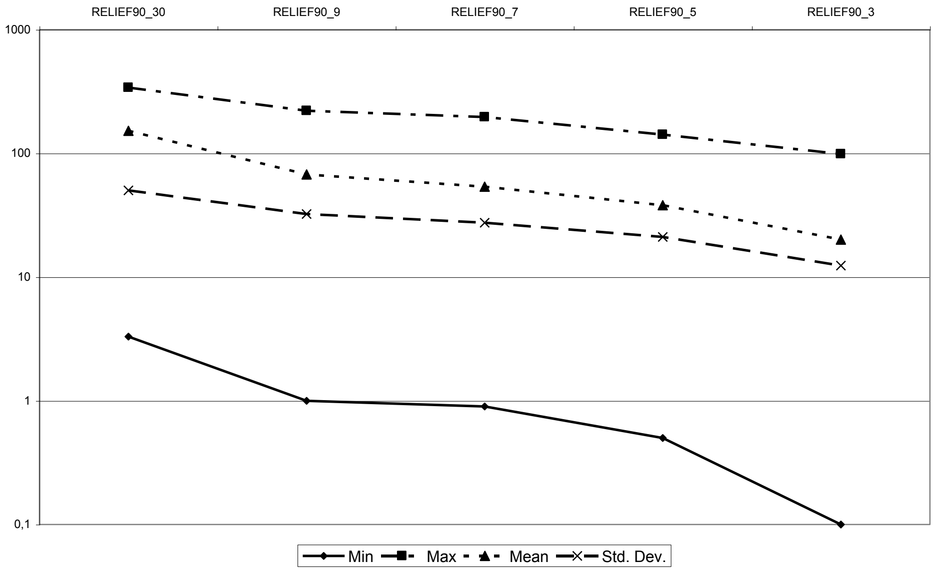

Figure 1 : *Variation of principal statistic values at different kernel window size for the same pixel size (90 m)*

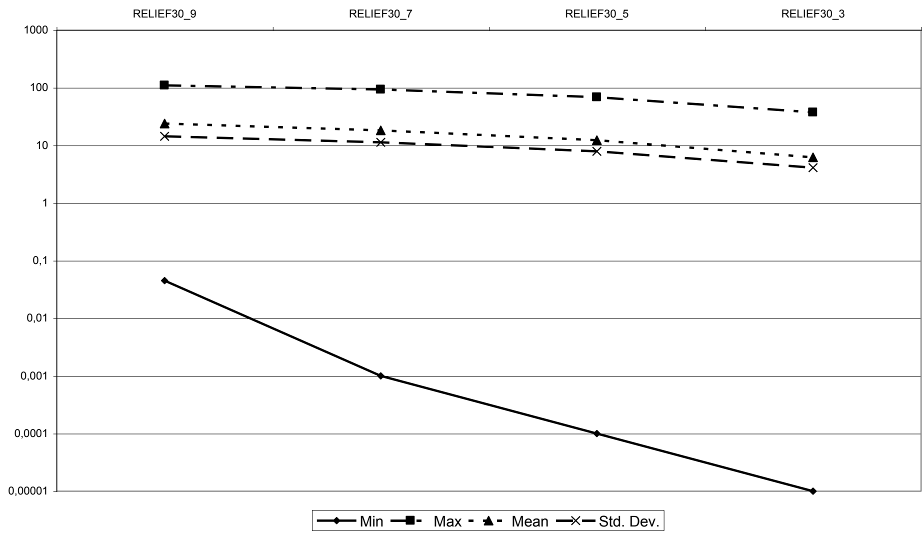

Figure 2 *: Variation of principal statistic values at different kernel window size for the same pixel size (30 m)*

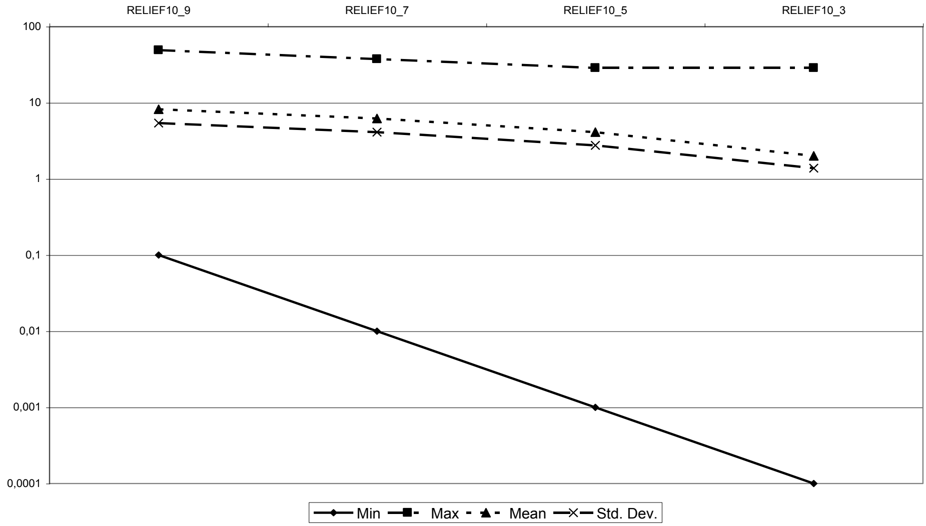

Figure 3: *Variation of principal statistic values at different kernel window size for the same pixel size (10 m)*

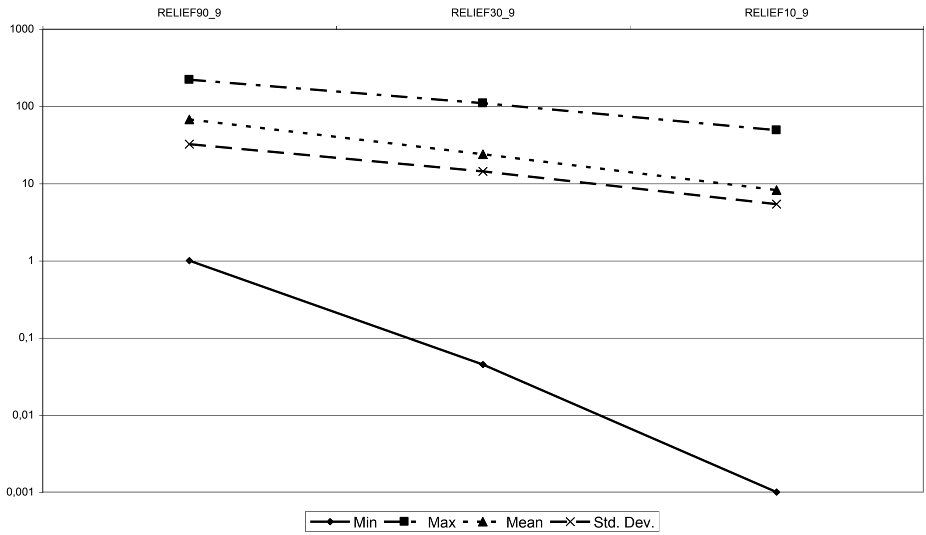

Figure 4 : *Variation of principal statistic values at the same kernel window size for different pixel size*

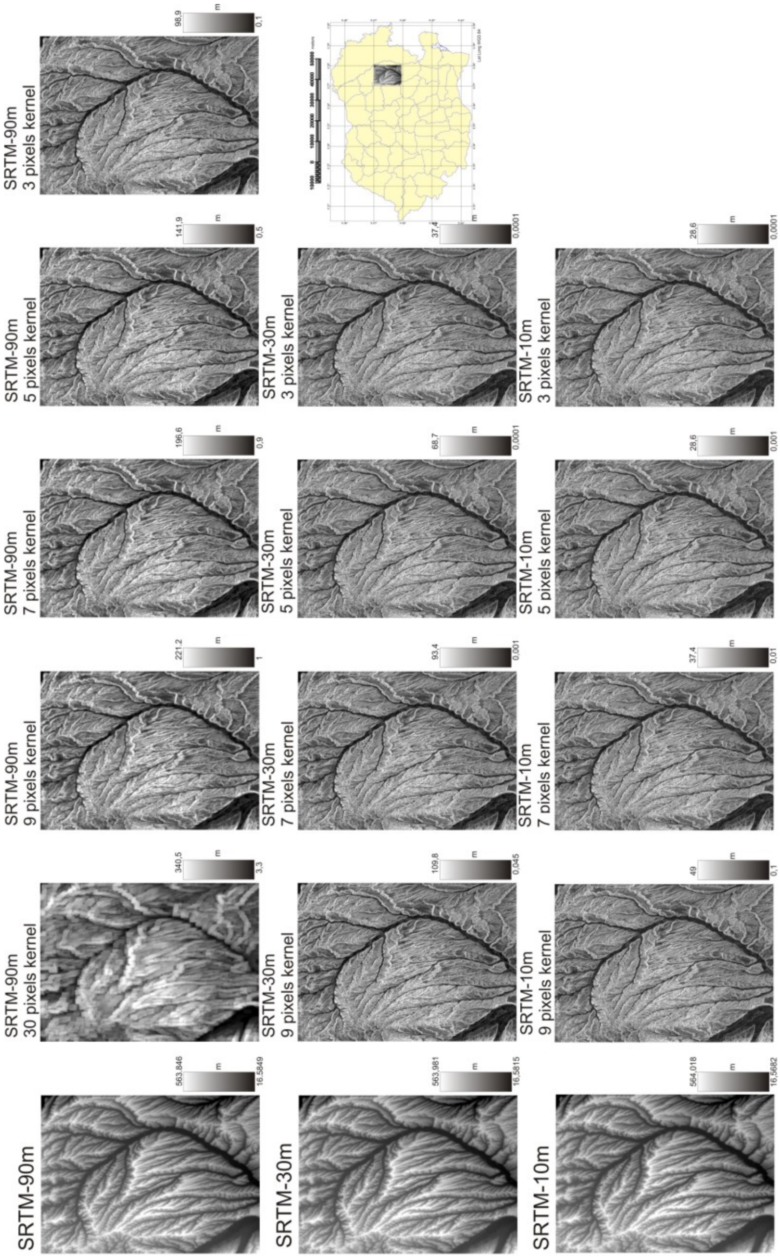

Figure 5 : *Raster computation of relief on SRTM DEM*

Conclusions

The raster computation of relief includes this geomorphometrical parameter in the list of geomorphometrical parameters efficiently computed by Digital Elevation Models and opens the wide geomorphological implications of this parameter: landform characterization, landform evolution (Ahnert, 1984) and landform classification (Brabyn, 1998)

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Tnt Mips SML documentation downloaded from www.microimages.com